'First-Light' for Africa's Giant Eye:
1st Colour Images from SALT

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Exactly five years after groundbreaking, the Southern African Large Telescope (SALT) project has released its first colour images, marking the achievement of 'first light' and the successful debut of full operation for SALTICAM, a $600 000 digital camera designed and built for SALT at the South African Astronomical Observatory (SAAO). SALT is the largest optical telescope in the southern hemisphere, and equal to the largest in the world. Gathering more than 25 times as much light as any existing African telescope, SALT can detect objects as faint as a candle flame on the moon. The sample images now released for the first time were taken during the camera's first trial period of operation, which also achieved SALT's first significant scientific results.

SALTICAM will be important to research by all the partners involved in building SALT (*National Research Foundation of South Africa; Nicolaus Copernicus Astronomical Center of the Polish Academy of Sciences and a consortium of 3 Polish universities, comprising: Jagiellonian University, Nicolaus Copernicus University, and Adam Mickiewicz University; The Hobby-Eberly Telescope Board (representing Georg-August-Universität Göttingen, Ludwig-Maximilians-Universität München, Stanford University, The Pennsylvania State University, and The University of Texas at Austin); Rutgers, the State University of New Jersey (USA); Georg-August-Universität Göttingen (Germany); The University of Wisconsin-Madison (USA); University of Canterbury (New Zealand); University of North Carolina-Chapel Hill (USA); Dartmouth College (USA); Carnegie Mellon University (USA); United Kingdom SALT Consortium (UKSC), comprising: the Armagh Observatory, the University of Keele, the University of Central Lancashire, the University of Nottingham, the Open University and the University of Southampton).*

Five years ago, on the first day of southern hemisphere spring, a few hundred people gathered for the SALT ground-breaking ceremony. On a windswept hilltop near the tiny Karoo town of Sutherland, home since the early 1970s to SAAO's research telescopes, dignitaries turned the first soil. Much has happened since that historic day, and SALT is now nearing completion.

A major recent milestone was the installation in May of the last of the 91 hexagonal mirror segments that comprises SALT's mammoth primary mirror array, stretching 11 metres across. Another major milestone, which we are marking today, is attaining "first light" with the telescope's full array of mirrors and its new imaging camera, SALTICAM. The biggest milestone for 2005 will be the official opening of SALT on 10 November 2005 by South African President Thabo Mbeki.

An Icon for SciTech Development and Cooperation – Within Budget

"SALT was an initiative of South African astronomers that won support from the South African government, not simply because it was a leap forward in astronomical technology, but because of the host of spin-off benefits it could bring to the country", said project scientist David Buckley.

"Indeed the SALT project has become an iconic symbol for what can be achieved in Science and Technology in the new South Africa." SALT is not simply a South African project, however. It is an international partnership involving 11 different partners from 6 countries on 4 continents – including Germany, Poland, New Zealand, the UK and the USA. A talented team of local engineers and scientists have succeeded in building SALT on a rapid – for big telescope projects at least – 5 year timescale. Not only that, but the cost of construction has been kept to within the original budget of $20 million defined in 1998, even before the final designs were completed.

According to Kobus Meiring, project engineer, "This is due in part to the fact much of the original design concept for SALT was modeled on the Hobby-Eberly Telescope in Texas, giving a useful starting point and allowing SALT's engineers to make creative use of the 'lessons learned' with the only previous telescope of this type."

Science Achieved and Progress to Come

Limited scientific observations have already begun with SALT while completion of the telescope's commissioning continues over the coming months. In the next month or so, installation will begin of the major first generation instrument, the Prime Focus Imaging Spectrograph (designed and built for SALT by the *University of Wisconsin-Madison* and *Rutgers University*) – which is to be renamed the Robert Stobie Spectrograph in honour of the past SAAO Director and Chairperson of the SALT Board, Dr Robert S. Stobie. It was Bob Stobie's dedication and enthusiasm that helped launch, and later steer, the SALT project to success. His untimely death in May 2002 was felt by all his colleagues, and the renaming of this major instrument in his name is in recognition of his major role in the SALT project.

The declaration of first light signifies that SALT has arrived on the astronomical scene. There is still telescope and instrument commissioning to complete, as well as full optimisation of SALT and its subsystems. This will continue for several months, after which astronomers confidently expect that SALT and its instruments will meet or exceed all the original design goals. This process is already well under way with much achieved, and SALT is now in a very real sense an operational telescope.

Astronomers within the SALT consortium keenly look forward to the scientific fruits of what has been, until now, an extremely successful engineering project. Already proposals for observations have been submitted and approved, and these observations are now beginning with the imaging camera, SALTICAM. The same will be true for the Robert Stobie Spectrograph, once it completes its commissioning tests in October. Like the SALT consortium itself, the science programmes to be conducted on SALT will be many and varied – from studies of the most distant and faint galaxies to observations of solar system objects like asteroids and comets.

The Information Age Telescope

SALT is truly representative of the century in which it has been built, since not only is it a sophisticated computer controlled precision instrument, but it is also an Internet-age telescope. No longer will it be necessary for astronomers in the consortium to travel to SALT to use it. Instead they will submit their observing requests over the Internet and eventually, once the observations have been conducted by the dedicated SALT operations staff, they will also receive their data over the Internet. In many respects this makes SALT far more like a space-based telescope, like the Hubble Space Telescope, than its ground based cousins. The operational model for SALT, with SAAO operating the telescope on behalf of SALT's partners, will also be far closer to the way a telescope in orbit operates.

Bringing the Stars Home to Africa

But the scientific and engineering achievements of the SALT project would have fallen short of the vision that led the South African government (with standing applause from every political party) to approve SALT, unless it did more than provide a spectacular tool for southern African and overseas scientists to explore the universe and extend human knowledge.

Already the benefits have been tangible, with the provision of bursaries and scholarships to deserving South African students to study both in South Africa and abroad. These programmes have been directly sponsored by many of the partners in the SALT Foundation. A number of science education initiatives have also been catalysed by the project, and many more are foreseen. Financially South Africa has benefited by the awarding of ~60% of the contracts and tenders to construct SALT to South African industry, while total South African funding was only ~34% of the total, meaning a net inflow of foreign exchange. Likewise, many of the high tech aspects of the project were undertaken by South African industry, including the precision robotic tracking system. This has meant the acquiring of skills previously not present or fully realized in the country.

Finally, SALT, like the science it will produce, has the gift of inspiring the imagination. Young visitors to SALT, and youth encountering SALT in the media or in the classroom, will know that cutting-edge science can happen in southern Africa as well as in the fully developed world. Sparking interest in science in technology, pulling bright young minds into careers in science and technology, is the real future benefit to South Africa.

The SALT First Light Images

The images we show here are a first indication of SALT's capabilities. While the imaging quality is not yet at its final optimal value, the sheer light gathering power of the telescope is amply demonstrated in these images. Most of the colour images were produced by combining separate images in three filters: ultraviolet (U), visible (V) and infrared (I), each with an exposure time typically of 10 – 120 seconds. The galaxy image (NGC6744) was made by combining ultraviolet, blue and infrared images. Eventually the sharpness of SALT's images will be improved by the full implementation of its active optics control, but although this is not yet operational, ***the best frames produced by SALT and SALTICAM show star images as small as 1 arcsecond (1/3600 degree), despite being taken when the seeing was 0.9-1.0 arcseconds.***

From Dr. Phil Charles, Director:

"I am delighted with these First Light images and results that demonstrate the level of operation we have already attained. Of course, we expect these capabilities to improve further as the final construction work is completed and commissioned (particularly the mirror's edge sensors that maintain the mirror "shape"). To have achieved this within 5 years of the groundbreaking ceremony is a splendid testament to the efforts of the entire SALT Project Team, and I give my hearty congratulations to the Project Manager and Project Scientist, who have set a benchmark for the entire international community. We look forward with great anticipation to the first year of SALT science operations."

Information on each of the first light images

1. 47 Tucanae

This image of the globular star cluster known as 47 Tucanae was obtained by combining images taken through three different filters with total exposure times of 120 sec (U filter), 20 sec (V filter) and 20 sec (I filter). 47 Tucanae is an ancient cluster of several million stars (as many as in some very small galaxies), about 15,000 light years from Earth, and 120 light years across. The stars in 47 Tuc are about 10-12 billion years old, making them among the oldest stars in the galaxy (more than twice the age of our own sun). Near the centre of 47 Tuc, stars are so densely packed that solar systems like ours might well be disrupted by passing stars, and night skies might never be fully dark. Such clusters, with huge numbers of stars about the same age, are living laboratories for studies of the life, birth, and death of stars.

2. NGC 6152

NGC 6152 is a small 'open cluster', a group of stars which all formed at about the same time perhaps a billion years ago. These few dozen stars formed close enough to each other that gravity has kept them travelling together around the centre of our galaxy since they were born. In this image the stars appear relatively sharp across the picture, because the 91 mirrors in SALT's primary mirror array are aligned fairly close to optimum. This is the only image which shows what a normal SALTICAM image looks like. The camera uses two CCD chips, with a small gap between them. In the other colour composites in this press release, multiple images have been combined to remove the gap.

3. NGC6744

NGC 6744 is a large face-on barred spiral galaxy in the star-rich southern constellation of Pavo. It lies at a distance of approximately 30 million light years, and is almost 150 000 light years across. Its overall appearance, shape and size are very much like our own Milky Way galaxy, and astronomers in NGC 6744 would probably see a rather sight in their telescopes if they looked in our direction. Like our galaxy, it contains more than a hundred thousand million stars. Stars like our own sun are far too insignificant to show up individually in this picture – they can only contribute to the general glow.

The bright nucleus of NGC 6744, as other spiral galaxies, is dominated by older reddish and yellowish stars, while the widely and thinly spreading spiral arms are home to bluer and younger stars. Hot star-forming regions, called HII regions for the ionised hydrogen gas they contain, are evident as fuzzy blue spots along the spiral arms. Dark lanes and patches show dust which is obscuring the light of the stars.

This picture clearly shows the enormous light-gathering power of SALT. The individual colour filter exposures in ultraviolet, blue and infrared lasted only 10 seconds each, yet the intricate spiral arms, which have very low surface brightness in this face-on galaxy, stand out clearly in these short exposures even though there was a 40% illuminated moon in the sky at the time.

4. The Lagoon Nebula (Central Regions)

The Lagoon Nebula is a region about 3800 light years away in which stars of high mass and luminosity are being born, emitting enough ultraviolet radiation to stimulate atoms in the surrounding gas clouds to emit light. This eerie glow typical of an "emission nebula" is shown in this colourful SALTICAM image, produced by combining images in three filters: 120 sec in U, 20 sec in V and 40 sec in I. The image is about ten arcminutes across (a third of the apparent width of the full moon in the sky), which corresponds to about 10 light years at the distance of the Lagoon. The entire cloud extends over 300 light years, while the region viewed here includes the youngest stars and the fascinating Hourglass nebula (the brightest feature in the image).

The enormous light-gathering capability of SALT will allow scientists to study motions in the gas cloud, as well as other details that may revise our ideas of how stars are born. We may better understand how stars in the Lagoon interact with the cloud in which they form, and with previous generations of stars.

5. NGC 6530 (Lagoon Nebula 2)

NGC 6530 is a cluster of 50-100 stars which formed about 2 million years ago from the gas clouds of the Lagoon Nebula, a part of which can be seen in the background. The hottest and most massive cluster member is about 40-50 times as massive as our sun, and is hundreds of thousands of times brighter.

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